Nottingham City Council

Flood Investigation Report

23 July 2013 Flood Event

Winchester Street, Spondon Street and Haydn Road, Sherwood, Nottingham

December 2015

Report prepared under Section 19 of the Flood & Water Management Act 2010

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FLOOD INVESTIGATION REPORT SUMMARY

Nottingham City Council is a Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (2010).

Section 19 of the Act states that on becoming aware of a flood the LLFA must, where appropriate, investigate which Risk Management Authorities have relevant flood risk management functions and whether they have exercised, or are proposing to exercise, those functions in response to the flood.

A number of thunderstorms passed over the City on 22nd and 23rd July 2013. On the evening of 23rd July 2013 an intense storm passed over the north of Nottingham causing over 100 residential properties to flood across the City. Nottingham City Council has received reports of 19 domestic properties and one business that suffered internal flooding in the vicinity of Winchester Street and Haydn Road in Sherwood and Carrington. The highway network was also affected by extensive sewer and surface water flooding.

This Flood Investigation Report has been completed by the City Council in consultation with relevant Risk Management Authorities. The report summarises the formal investigation that has been undertaken, including any factors that contributed the causes and impacts of the flood event and describes all roles and responsibilities and future actions.

1 INTRODUCTION

1.1 What is a Formal Flood Investigation?

Flooding has a devastating impact that affects people, property, business, the environment and transport. There are many different sources of flooding including rivers, sewers, surface water and groundwater and there are a number of Authorities and organisations involved in managing the risk of flooding from these different sources. Flooding can be caused by a complex interaction of different sources that can be difficult to resolve, particularly in urban areas.

Nottingham City Council is a Lead Local Flood Authority (LLFA) under the Flood and Water Management Act (2010). In recognition of the complex nature of flooding and the number of different Authorities that can be involved, Section 19 of the Act places a duty on the City Council to investigate the causes of flood events in their area, as appropriate. The legislative requirements of Section 19 are included below.

Flood and Water Management Act (2010) – Section 19

(1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate—

(a) which risk management authorities have relevant flood risk management functions, and

(b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under subsection (1) it must—

(a) publish the results of its investigation, and

(b) notify any relevant risk management authorities.

This report has been prepared in response to the legislative requirement.

1.2 Which Authorities are involved?

The Flood and Water Management Act (2010) identifies organisations that have flood risk management responsibilities as 'Risk Management Authorities'. Table 1 shows the key responsibilities of Risk Management Authorities that operate in the Nottingham City area.

Due to the number of different organisations involved, the City Council is responsible for leading on flood investigations and works in partnership with relevant Risk Management Authorities. Through leading the investigation, the City Council will identify which Risk Management Authorities have

flood risk management functions in relation to the flood event and what actions they propose to take, if any, to reduce flood risk in the future.

Table 1: Risk Management Authorities in Nottingham City Council's administrative area

Risk Management Authority	Flood Risk Management Functions
Lead Local Flood Authority & Highway Authority: Nottingham City Council	• River (fluvial) flooding from minor watercourses ('Ordinary Watercourses') • Surface water (pluvial) flooding • Groundwater flooding • Provision and maintenance of highway drains and road gullies
Water and Sewerage Company: Severn Trent Water	• Providing effectual drainage • Maintaining adopted public sewerage network
Environment Agency	• River (fluvial) flooding from large watercourses ('Main Rivers') • Flooding from the Sea and estuaries • Reservoir flooding

1.3 When are Formal Flood Investigations undertaken?

The City Council has developed thresholds and triggers for when a formal investigation will be undertaken following a flood event. The thresholds relevant to this Flood Investigation Report are summarised below:

Nottingham City Council Thresholds for Initiating Flood Investigations

For a residential dwelling such as houses or flats including Nottingham City Homes properties a Section 19 flood investigation shall be carried out where:

- internal (over the doorstep) flooding affects five or more properties and the properties are either in close proximity or the flooding is hydraulically linked.

The flood event on 23rd July 2013 caused the internal flooding of 19 domestic properties and one business within a catchment that covers Haydn Road, Winchester Street and surrounding roads (and are therefore 'hydraulically linked'). This Flood Investigation Report has been compiled because the number of properties that experienced internal flooding exceeds the thresholds that have been set by the City Council.

2 DESCRIPTION OF THE LOCAL AREA

2.1 Location of the flooding incident and the local area

Winchester Street, Spondon Street and Haydn Road are located approximately 3km north of Nottingham City Centre in the areas of Sherwood and Carrington (Figure 1). The area is predominately residential with some retail and commercial premises.

An elevation map for the area is shown in Figure 1 along with the approximate boundary of the hydrological catchment area. The land falls in a westerly direction, from the Mapperley in the east towards the River Leen in the west. The north and south of the catchment are formed by high ground in the vicinity of Perry Road and Arlington Drive / Herbert Road, respectively. Cavendish Vale and Haydn Road run approximately along the bottom of the valley. Ground levels fall from approximately 130 metres Above Ordnance Datum (mAOD) to the east off Woodthorpe Road to approximately 45 mAOD on Haydn Road (near to the Quorn Road junction) and the valley continues to fall in the direction of the River Leen to the west.

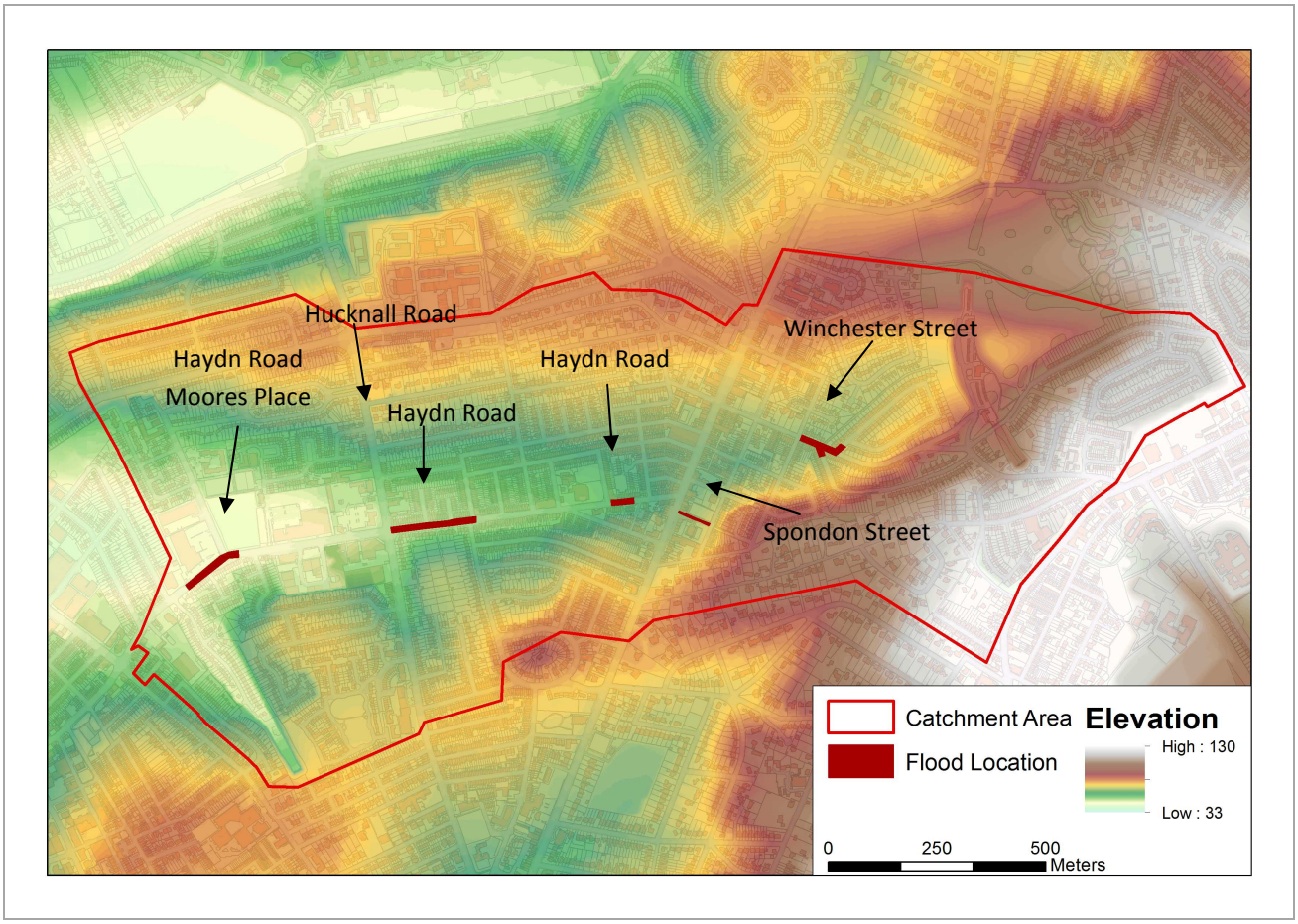

Figure 1: Site Location and Topography.

The Winchester Street and Spondon Street areas of Sherwood started to be developed in the late 1800's and the vast majority of the existing properties in the vicinity, including Cavendish Vale and Dornoch Avenue, were constructed by the early 1900's. Further properties were constructed on Winchester Street in the 1960's. The area is predominantly residential today, with a greater density of retail premises towards the centre of Sherwood in the vicinity of Mansfield Road.

Development of Haydn Road, to the east of Hucknall Road, began at the turn of the 20th century with the majority of the existing properties constructed by 1910. Further development of Haydn Road near to the Hucknall Road junction, and surrounding roads such as Devonshire Drive took place in the 1930's and 1940's and the area remains predominantly residential today.

Haydn Road to the west of Hucknall Road was developed later than the areas described above, but has changed greatly over the decades. The first evidence of development is in the late 1800's with the construction of a reservoir on the site currently occupied by Severn Trent Water and a hosiery factory on the site currently occupied by Courthaulds. The Central Railway was also constructed at this time and passed through the area to an embankment and was bridged over Haydn Road. The New Basford Station was located on Haydn Road in the area that is now occupied by properties on Langdon Close and Moores Place. The landscape created for the railway remains in places today, with a low spot evident on Haydn Road where the road was lowered to pass beneath the former railway bridge. The remainder of the area was largely undeveloped until the 1930's and 1940's when further commercial properties on Haydn Road and residential development on surrounding roads, including Warren Avenue and Glamis Road, were constructed. Following the demise of the Central Railway, the New Basford Station and railway bridge were demolished and factories were constructed to the north and south of Haydn Road in the vicinity of Haydn Road. To the south of Haydn Road the factory was demolished and replaced with around 50 new residential properties that now occupy Moores Place and Langdon Close. Construction of this site was completed in 2008. The factory and warehouse to the north of Haydn Road were occupied by two car showrooms for several years, one of which, at the junction of Glamis Road, was demolished in 2014. The car showroom at the junction of Quorn Road remains in use.

Development within the wider catchment largely reflects the areas described above, with the majority of the area built up during the late 1800's and early 1900's, with further development in the 1950's and 1960's. A number of new developments were constructed during the 1990's and 2000's, including aforementioned Moores Place / Langdon Close development on Haydn Road and the Kelham Drive estate and Caxton Road estate, both of which are off Hucknall Road. These recent developments were all on former industrial land.

2.2 Local river and drainage systems

There is an Ordinary Watercourse within the vicinity of Winchester Street. The watercourse drains a small area, approximately 8.5ha, of Woodthorpe Grange Park to the east and flows in open channel

to the rear of properties on Cavendish Vale before entering a short length of culvert which connects into a large 1100mm diameter combined public sewer beneath Winchester Street. The entrance to the culvert is protected by a trashscreen and reduces the maximum cross sectional area to approximately 0.16m^2. The watercourse then passes through a silt trap and enters an inspection chamber through a 225mm diameter pipe. The watercourse then enters the public sewer network through a 225mm diameter pipe. It is not known when this watercourse was incorporated into the sewerage system, but historic maps indicate that the arrangement was similar to the existing arrangement in 1875. Prior to development is it likely that the watercourse was a tributary of the River Leen and flowed along the bottom of the valley identified in Figure 1. During dry weather conditions, the flow within the watercourse is minor, reflecting the small catchment area.

The River Leen is located to the west of the catchment area, approximately 0.9km from the western-most area affected by flooding on Haydn Road and 2.4km to the west of Winchester Street (the eastern-most flooding incident).

Due to the historic development of the area, almost the entire catchment is served by a combined sewerage system that collects waste water and rain water. The main sewer flows in a westerly direction from its source in the Mapperley area, along Winchester Street, Mansfield Road and Haydn Road before continuing down North Gate. The main sewer increases in size from 1100mm diameter on Winchester Street to 1380mm diameter on Haydn Road (to the west of Hucknall Road) to accommodate additional flows that connect into the main sewer from side roads. In 2002, Severn Trent Water constructed two offline storage tanks (6000m^3) within their Haydn Road depot as part of the Radford Road Area Flood Alleviation Project in response to sewer flooding issues downstream of Haydn Road. During storm conditions, flows in the main sewer should spill into the tanks, reducing the risk of sewer flooding on Haydn Road to the west of Hucknall Road. The tanks are monitored by alarm systems. At the time of the July 2013 flood incident, the tanks were served by a high level alarm that only triggered when either there was a specific equipment failure or the tanks were sitting ‘High’ or full for a long period of time (i.e. it was not possible to monitor actual water levels). These alarms have since been improved to provide constant monitoring of levels within the tanks.

Areas of newer development are served by separate sewerage systems that consist of two pipes: one taking waste water (foul sewer) and one taking rain water (surface water sewer). The developments at Moores Place / Langdon Close, Sheridan Way, Caxton Road and Kelham Drive are all served by separate sewerage systems, in line with modern building regulations. In all cases, the separate sewerage systems then discharge into the combined sewers that ultimately drain to the main sewer along Haydn Road.

2.3 Historical flood events

The City Council holds the following flood records for the areas under investigation:

- **6 July 2009:** Internal flooding of two properties at Moores Place on Haydn Road to the west of Hucknall Road.

- **5 / 6 June 2010:** Caused internal flooding of six properties at Moores Place on Haydn Road to the west of Hucknall Road and the basement of one property on Winchester Street.

- **28 June 2012:** Internal flooding of one property on Winchester Street, external flooding affecting highway and gardens on Winchester Street and Dornoch Avenue.

The City Council did not hold formal flooding records prior to 2008. Anecdotal evidence collected throughout this investigation indicates that Winchester Street and Haydn Road (both east and west of Hucknall Road) have suffered flooding on a number of previous occasions.

Nottingham City Council and Severn Trent Water hold no records of internal or external flooding on Spondon Street prior to the flood event on 23rd July 2013 and there is no anecdotal evidence suggesting there has been historical flooding in the area.

Severn Trent Water holds no records of flooding on Haydn Road, east of Hucknall Road or on Winchester Street prior to the 23rd July 2013.

2.4 Areas predicted to flood

The Environment Agency's Flood Map for Surface Water is a national dataset which shows areas that are predicted to be at risk of flooding from surface water. The Map was made publically available on the Environment Agency's website[1] in December 2013.

The Flood Map for Surface Water shows the following in relation to the areas that suffered flooding on 23rd July 2013:

- The area at the junction of Winchester Street and Dornoch Avenue is at a high risk of surface water flooding.

- Spondon Street is at a low risk of surface water flooding.

- Haydn Road is at a high risk of surface water flooding both to the east and west of Hucknall Road, with a notable area of ponding predicted near to the Glamis Road junction.

High risk means that each year, there is a chance of flooding of greater than 1 in 30 (3.3%). Areas at Medium risk (chance of flooding between the 1 in 30 and 1 in 100), Low risk (chance of flooding

[1] Environment Agency Flood Map for Surface Water, available online at maps.environment-agency.gov.uk, select 'Risk of Flooding from Surface Water'

between the 1 in 100 and 1 in 1000) and Very Low risk (chance of flooding of less than 1 in 1000) are also indicted on the Map. The Map also shows that the flood flow route follows the natural valley identified in Section 2.1.

An extract from the Flood Map for Surface Water is included in Appendix A

3 CAUSES AND IMPACTS OF FLOODING

3.1 Weather conditions before and during the event

General conditions in the weeks leading up to the 23rd July 2013 were dry. Rainfall data from the City Council's rain gauge network shows that between 21:00 on 22nd July and 12:30 on 23rd July three rainfall events occurred. The Bulwell Riverside rain gauge, which is located 3-4km north west of the affected area, recorded a total of 24mm of rain during this time (Figure 2, Events 1, 2 & 3).

At 17:00 on 23rd July an intense storm moved south west to north east across the north of Nottingham City, including the Carrington and Sherwood areas (Figure 2, Event 4). Rainfall data from the Bulwell Riverside rain gauge recorded 25.8mm of rain in 29 minutes, though affected residents in the Sherwood area recall the rain lasting for up to an hour. At the peak of the storm 17mm of rain was recorded in 10 minutes. It is important to note that rainfall can vary greatly over short distances and that the rainfall data reported here was recorded at Bulwell. The flood event started during the intense rainfall event at 17:00 on 23rd July.

The City Council commissioned a report to undertake detailed analysis of the rainfall data from the Bulwell rain gauge. This concluded that the main storm at 1700 was a 1 in 36 annual probability event.

The annual probability of the rainfall event is important because the current industry standard for design of sewers is to accommodate flows for up to the 1 in 30 year annual probability rainfall event. More severe storm events are therefore more likely to exceed this design capacity and possibly overwhelm the public sewer network. Sewerage systems are designed to the modern water industry standard and are ordinarily expected to accommodate the 1 in 30 year event however; the historic combined sewer network in the area predates these current design standards and may not be constructed to accommodate such large events. The rainfall event exceeded the design standard and Severn Trent Water therefore class the event as 'extreme'.

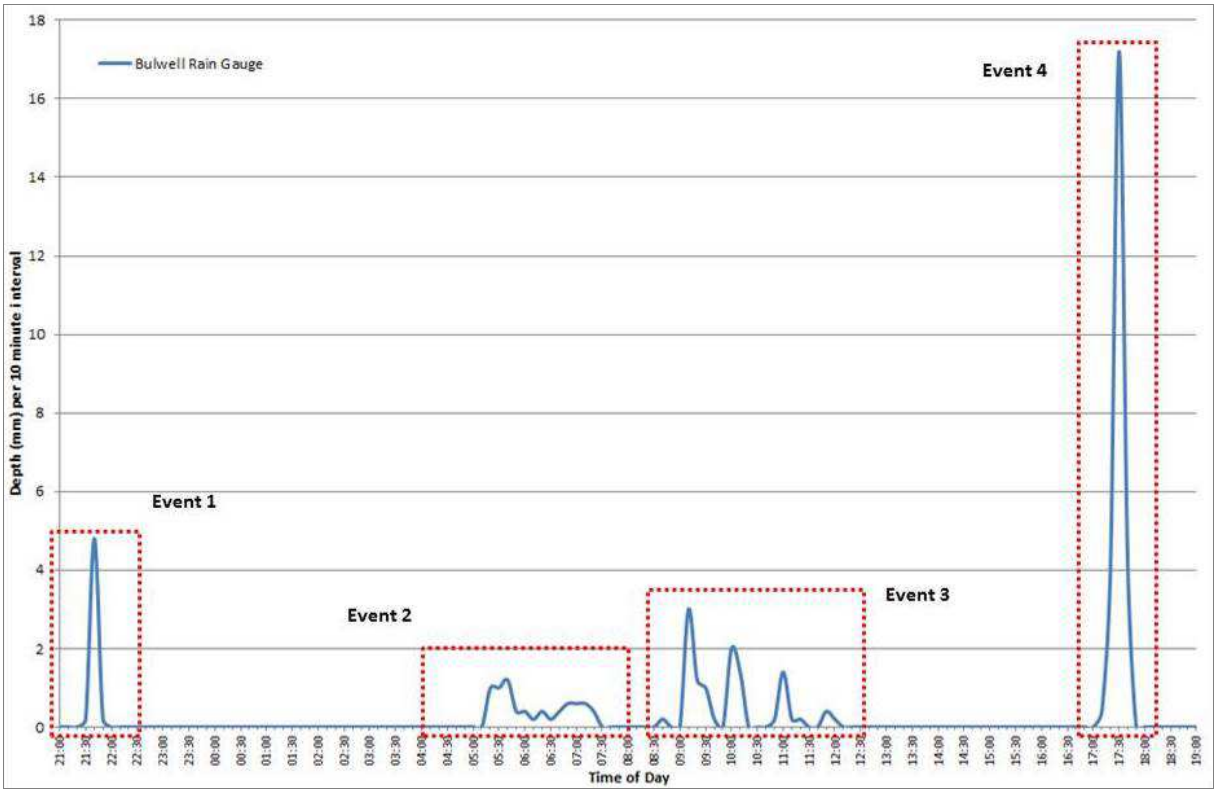

Figure 2: Rain gauge data from Bulwell for the evening of 22nd July 2013 and throughout 23rd July 2013

3.2 Flooding mechanisms and impacts

3.2.1 Observed flooding mechanism

The flooding of properties on Winchester Street, Haydn Road and Spondon Street occurred during and after the intense rainfall event at 1700 on 23rd July 2013. It is likely that rainfall in the 24 hours before the main rainfall event (Figure 2, Events 1-3) had filled much of the storage available in the sewerage system and saturated areas of green open space both locally and within the wider catchment area. This, combined with the intensity of the main rainfall event, resulted in rapid overland flow, surcharging sewerage systems and ponding of surface water in low lying areas.

The steep topography of the catchment channelled surface water towards the main conduits of Winchester Street and Haydn Road and west towards the River Leen (Figure 3). The ordinary watercourse that flows along the rear of Cavendish Vale contributed to flooding in Winchester Street.

A more detailed discussion of the flooding mechanisms are included in the following sections.

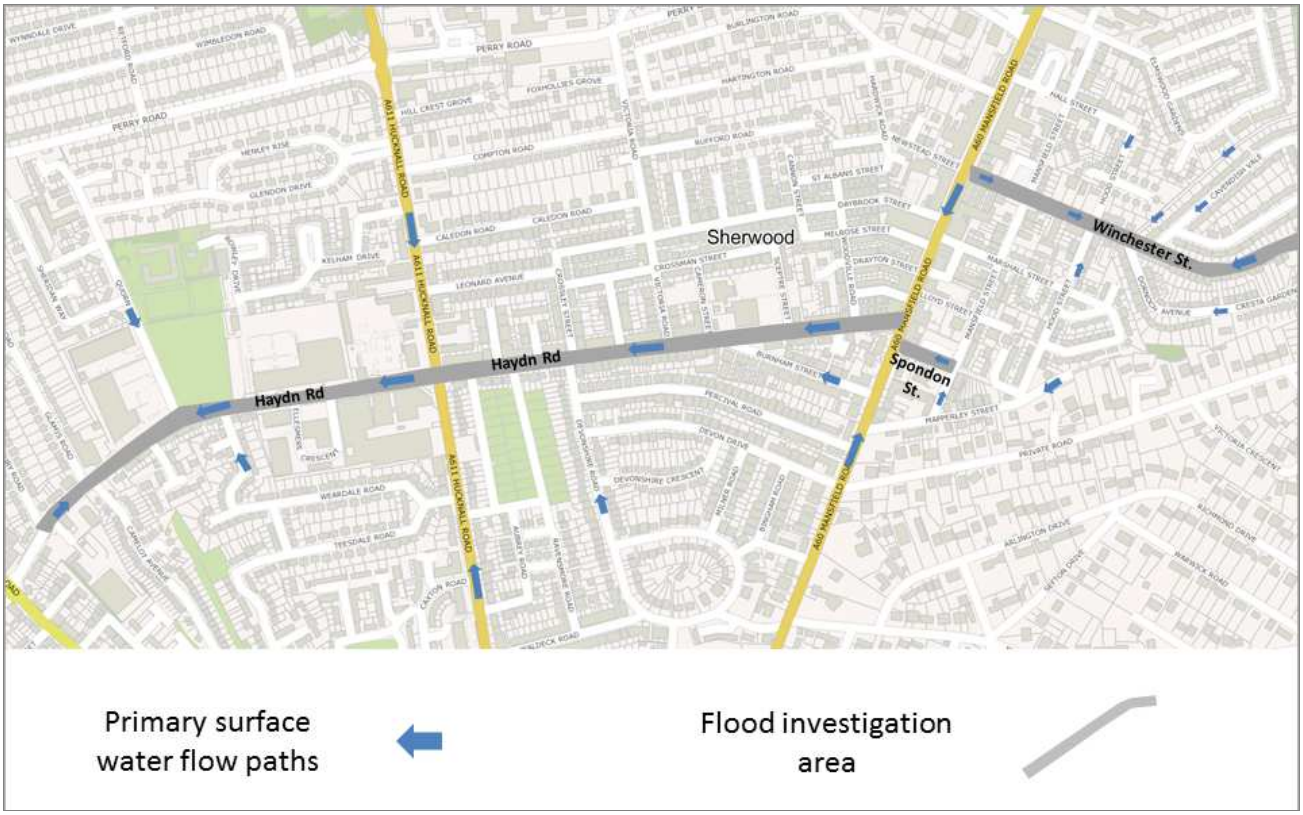

Figure 3: Primary routes of surface water during the flood event for the whole catchment.
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3.2.2 Winchester Street

Residents at Winchester Street report water rapidly flowing downhill along highways and converging on Winchester Street (Figure 4). Both Winchester Street and Dornoch Avenue have a steep gradient that results in the rapid flow of water from high ground to low ground which converges at the junction of Dornoch Avenue and Winchester Street. At this low point in the surrounding landscape water is collected from as far away as Mapperely Rise, Woodthorpe Grange Park, Woodthorpe Road and Woodborough Road.

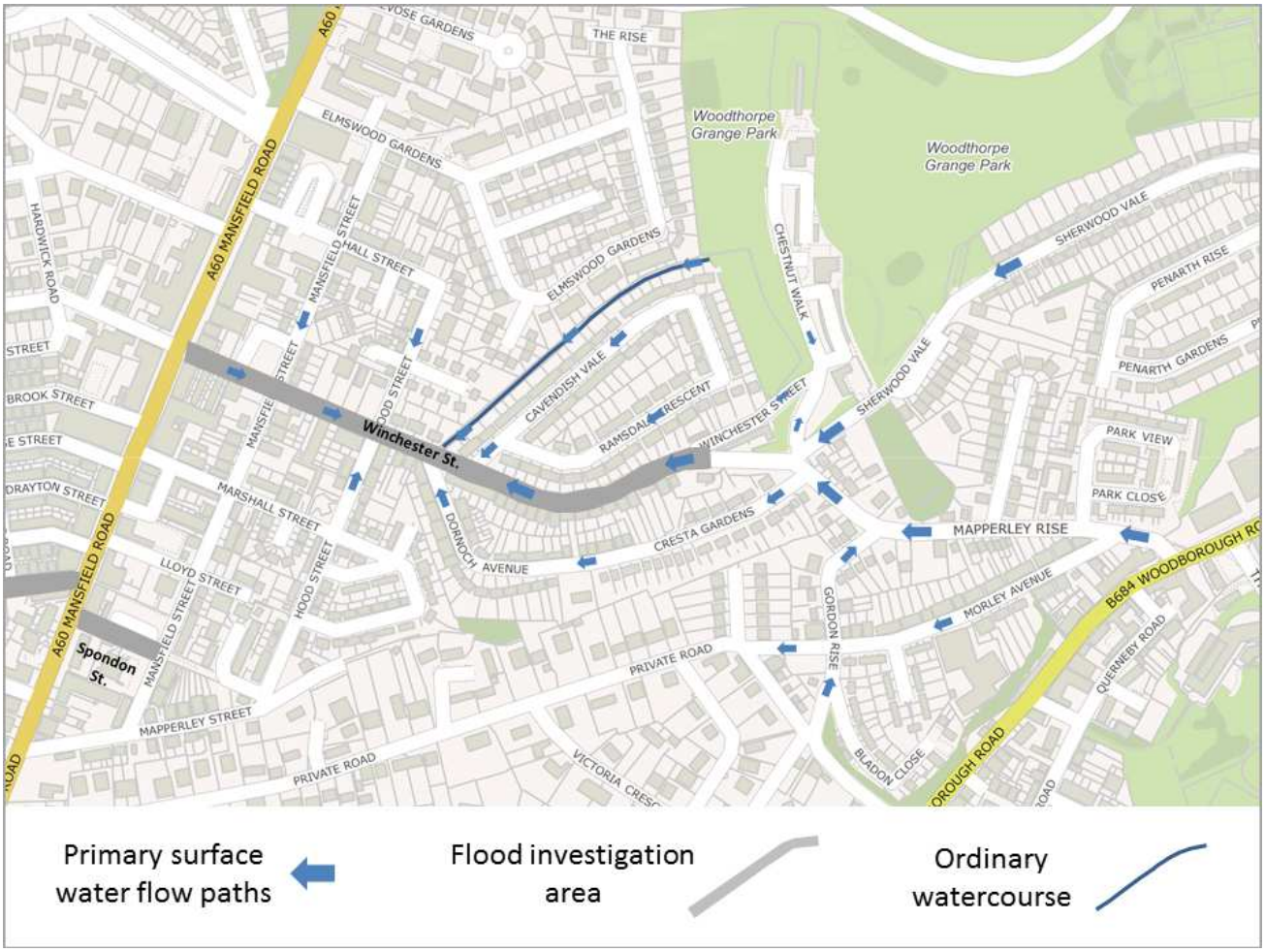

Figure 4: Primary flow paths for flooding on Winchester Street. © Crown copyright and database right 2012. Ordnance Survey Licence number 100019317.

Residents observed that the highway gullies on Winchester Street were overwhelmed during the storm and were unable to drain water away. Nottingham City Council's records show that the highway gullies on Winchester Street and Dornoch Avenue were jetted and cleared on the 24th June 2013 which suggests they should have been functioning correctly on 23rd July 2013.

Further to this residents report that the ordinary watercourse that flows behind Cavendish Vale was unable to freely enter the combined public sewer on Winchester Street causing water to back up and eventually overtop the culvert and flow onto the highway. This is indicative of the public sewer network being at capacity which is further supported by photographic evidence of fountains of water emerging from stop taps and a manhole during the height of the storm.

The ordinary watercourse enters the combined public sewer through a culvert on Winchester Street (Figure 5). It is unclear how much additional flow the watercourse added to the public sewer network during the storm on the 23rd July 2013 but there would have been an increase in flow volumes. It is approximated that the 225mm outlet pipe into the public sewer network would provide a maximum flow rate of 50l/s assuming the pipe is at full bore, there is a free outfall and a

gradient of 1 in 100. It is likely that Woodthorpe Grange Park and the surrounding green spaces that the watercourse drains were saturated prior to the storm(See Section 3.1) increasing the amount of runoff during the flood event at 5pm on 23rd July 2013. This additional volume will have added pressure to an already strained system.

The flood level rose quickly during the storm as water pooled at the lowest point on Winchester Street causing the internal flooding of one property and the external flooding of at least 9 properties (Figure 6). Residents report external flood depths of up to approximately 300mm and water was able to enter the flooded property through air bricks and the front door.

Figure 5: Ordinary watercourse that flows from Woodthorpe Grange Park behind Cavendish Vale and joins the public sewer network at Winchester Street. NE facing from Winchester Street.

Figure 6: Winchester Street facing north west.

The interaction between the highway drainage, ordinary watercourse and public sewer network is complex. As a result, once the public sewer reached capacity water from the ordinary watercourse, the combined public sewer system and overland flow contributed to flood volumes on Winchester Street. It is reported that the flood waters receded between half an hour and an hour after the storm had passed indicating both the highway drainage and public sewer network are functioning in the area.

None of the residents reported sewage in the flood water.

3.2.3 Spondon Street

Reports from the property affected by flooding on Spondon Street show that the primary mechanism for the flooding was surface water flowing from the car park on the north side of Spondon Street. It is likely that surface water flowing along Mapperley Street and Mansfield Street also contributed to the surface water volume in Spondon Street due to the local topography (Figure 7).

Figure 7: Primary surface water flow paths for flooding on Haydn Road, east of Hucknall Road. © Crown copyright and database right 2012. Ordnance Survey Licence number 100019317.

The car park is approximately 1500m^2 and falls steeply to the west. It was observed that gullies in the car park and on Spondon Street became overwhelmed. Some of the gullies within the car park were reported to be blocked at the time of the flood event so further contributing to flood volumes. Once the water could not drain away water was able to pool at the west end of the car park and this led to the internal flooding of one commercial property. There are no reports of sewage within the flood waters indicating that it was only surface water flooding at this location.

Records show that the gullies in the Spondon Street car park were last cleaned in June 2014.

3.2.4 Haydn Road (East of Hucknall Road)

Haydn Road runs north east to south west along a valley that drains the wider Sherwood and Mapperley area. Interconnecting roadways create flow paths for surface water to travel downhill towards the west end of Haydn Road and eventually towards the River Leen (Figure 7). On Haydn Road, east of Hucknall Road, residents report surface water rapidly flowing downhill along Devonshire Road and Burnham Street and collecting on Haydn Road.

The public sewer network at this point on Haydn Road is draining a large area of Sherwood and Mapperley and is predominately served by a combined sewerage system with a main trunk beneath the middle of Haydn Road. Photographic and video evidence shows that manholes on Haydn Road were surcharging and one manhole near the junction of Devonshire Road was ripped from the carriageway requiring emergency repair. This evidence shows that the capacity of the sewerage system had been exceeded. Sewage was reported in the flood waters on Haydn Road. The road surface on a number of surrounding roads was damaged by overland flow.

During the storm, like on Winchester Street, the highway gullies on Haydn Road and surrounding streets were overwhelmed. Gullies on Haydn Road were acting in reverse due to the sewerage capacity being exceeded. The combination of sewer and overland flow caused water to pool within the highway and eventually breach the kerb and flood properties on Haydn Road. Evidence after the storm event shows that debris and soil was washed from adjoining areas contributing to the reduction of the functionality of some of the highway gullies on Haydn Road during the storm event. Nottingham City Council's records show that the highway gullies on Haydn Road, near the Hucknall Road junction, were cleared and functioning on 24th June 2013 so it is likely that prior to the storm they were working at or close to full capacity.

Figure 8: Flooding in 2012 on Haydn Road, east of Hucknall Road looking west towards the junction with Hucknall Road.

Water pooled near the junction with Hucknall Road because at this point the crown of Haydn Road rises creating a barrier to overland flow until it is overtopped and can continue west along Haydn Road (Figure 9). The crown of Hucknall Road determines the maximum depth to which water can pool on Haydn Road, to the east of Hucknall Road, before it can continue to flow downslope.

Figure 9: Crown of Hucknall Road at the junction with Haydn Road looking east. A fire truck is pumping water from a flooded cellar after a storm event.

A combination of surface water and public sewer surcharging led to the internal flooding of 12 properties on Haydn Road, to the east of Hucknall Road. Residents reported once the kerb was breached surface water rose to external depths of between 600 to 700 mm on Haydn Road. Flood waters entering the properties through airbricks, front doors and back doors causing reported internal flooding of between 80mm to 300mm deep. In some cases cellars were flooded to a greater depth and one resident had to have their cellar pumped out after the event.

3.2.5 Haydn Road (West of Hucknall Road)

Haydn Road, west of Hucknall Road is situated further along the valley bottom and has a drainage catchment of approximately 2km^2. Like the east end of Haydn Road, the steep surrounding roadways like Warren Avenue and Quorn Road allow surface water to travel rapidly towards Haydn Road, bypassing highway gullies because of the velocity of flow (Figure 10). Water may also have overtopped the crown of Hucknall Road and flowed down Haydn Road. A former railway bridge underpass on Haydn Road near Moores Place forms a topographic low point where water ponds. At this point, some properties have thresholds lower than the road. These properties have suffered flooding previously. In response to previous flooding Ward Councillors funded a low level flood wall with gates. The wall was approximately 0.6m in height.

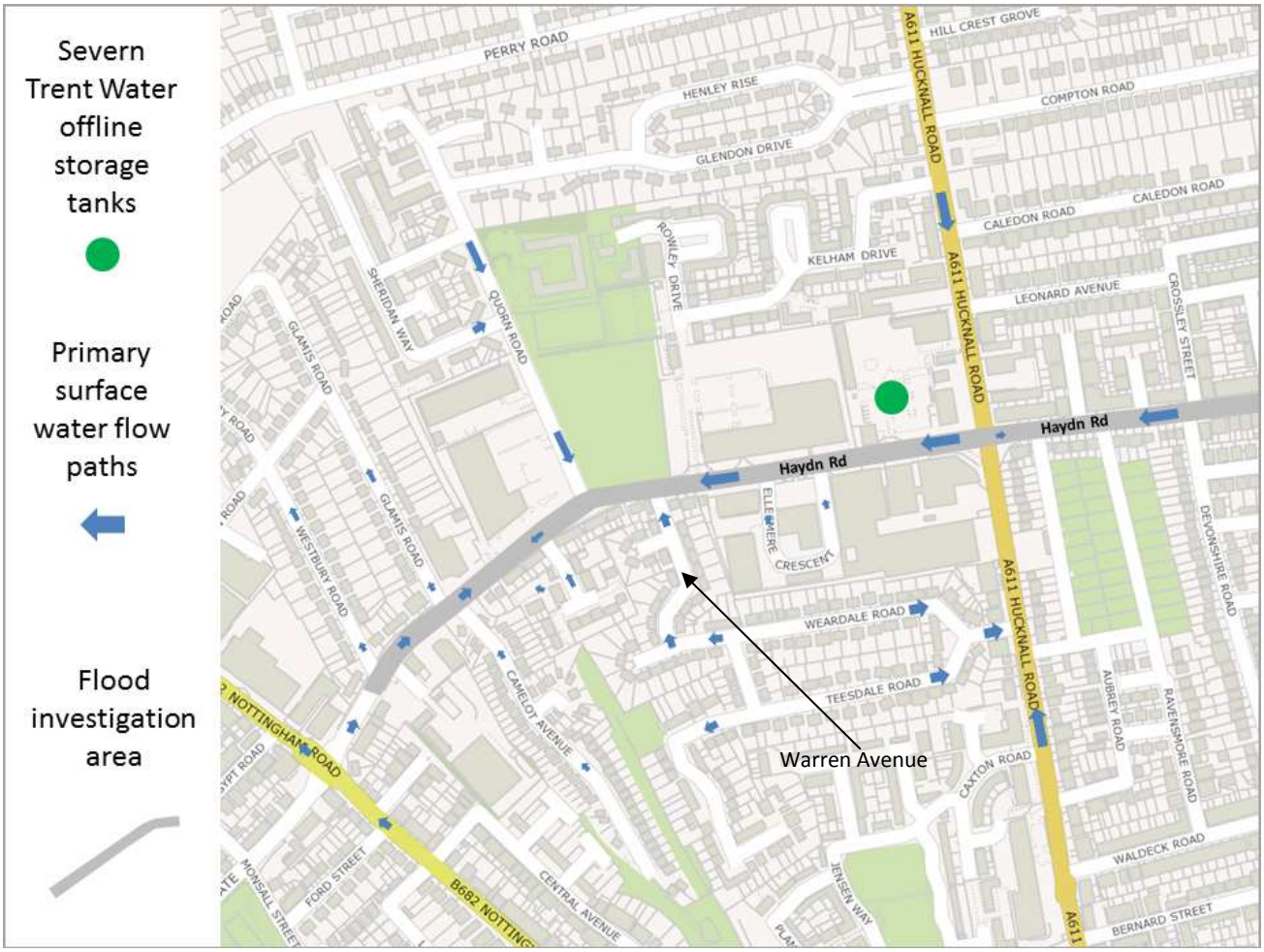

Figure 10: Primary surface water flow paths for flooding on Haydn Road, west of Hucknall Road. © Crown copyright and database right 2012. Ordnance Survey Licence number 100019317.

During the storm residents report that the highways gullies along Haydn Road were overwhelmed and unable to effectively drain surface water away. Water ponded in the lowest point in the highway and overtopped the flood defence wall. The properties suffered internal flooding of approximately 900mm. Due to the lay out of the properties, water was unable to flow out of the rear of the ground floor, causing flood water to accumulate.

Flattened vegetation at the west end of Moores Place observed after the flood event suggests that surface water was also flowing from the rear of the properties and further contributing to flood volumes. A car park forms an area of hard standing, approximately 400m^2 to the south (rear) of Moores place. It is uphill from the flooded properties and channels surface water from the surrounding hard standing to the North West corner of the carpark. It is unknown how much water contributes from this flooding mechanism but the flattened vegetation suggests water was flowing with a substantial velocity around the side of properties.

Severn Trent Water has two offline overflow storage tanks to increase the public sewer network capacity on Haydn Road and further downstream. The tanks are located on the west side of the

junction with Hucknall Road. At the time of the storm it is not clear how full the offline storage tanks were because the data received from the alarm system is not clear. These tanks are designed to relieve pressure on the public sewer network during times of storm and it is likely that the storms in the 24hrs preceding 5.00pm on 23rd July 2013 may have filled some of the capacity of the tanks. Severn Trent Water records show that there were no signals to indicate that the tanks were sitting 'High' or full for a long period of time during the storm or there was a specific equipment failure.

Residents report that there was sewage in the flood water and one resident reported that the ground floor toilet began to work in reverse and allowed sewage to enter the property. This was either because the public sewer network was at capacity during the flood event or alternatively, flood water entered the private drainage system and caused toilets to flood the ground floor. The highway gullies drain into the main trunk combined public sewer on Haydn Road and if the network was close to or at capacity during the storm this will have reduced the ability for surface water to be drained away.

It is concluded that a combination of surface water and surcharging public sewers led to the internal flooding of 6 properties on Haydn Road, west of Hucknall Road. Internal flood depths rose to 900mm during the storm and enter properties through front doors, air bricks, windows and surcharging internal toilets.

Figure 11: Haydn Road, west of Hucknall Road prior to the construction of flood walls.

3.2.6 Summary

Table 2 below summarises the properties flooded, the flooding mechanisms and impact of flooding for each of the areas within this report.

Table 2: Flooding impact on properties during the flood event

Location	Number of Properties Affected	Flooding Source	Impact
Winchester Street and Cavendish Vale, Sherwood	1 internal 10 external	• Small ditch flowing adjacent to Cavendish Vale • Sewerage system surcharged • 'Fountains' emerging from water supply covers • Surface water from the surrounding area.	• Extensive surface water flooding at the junction of Winchester Street and Dornoch Avenue • Internal flooding of one property on Winchester Street • External flooding of gardens and driveways of at least 9 properties on Winchester Street and one property on Cavendish Vale
Spondon Street, Sherwood	1 internal	• Surface water flooding from surrounding areas	• Internal flooding of one retail premise
Haydn Road (east of the Hucknall Road junction)	12 internal	• Sewer flooding emerging from a Severn Trent Water manhole and highway drainage • Surface water flowing down adjacent roads and ponding on Haydn Road	• Internal flooding of 11 neighbouring properties and a further property further east along Haydn Road • Public sewerage cover and frame ripped out of the road surface, causing extensive damage to the road surface • At least one vehicle damaged due to flood depths
Haydn Road (west of the Hucknall Road junction)	6 internal	• Surface water flowing from adjacent roads accumulating on Haydn Road • Sewer flooding from the local drainage network around the properties and potentially from the main public sewer	• Internal flooding of six properties and overtopping of a flood wall • At least one vehicle damaged due to flood depths

4 RESPONSIBILITIES, AGREED ACTIONS & RECOMMENDATIONS

4.1 Which Risk Management Authorities have flood risk management functions in relation to the flood event

The flooding that occurred in the Winchester Street, Spondon Street and Haydn Road area was as a result of intense rainfall that generated large volumes of surface water runoff and likely overwhelmed drainage systems causing water to pond in low lying areas. The following authorities therefore have flood risk management functions in relation to the flood event:

- **Nottingham City Council** is responsible for managing flood risk from surface water and for providing and maintaining highway drainage systems.
- **Severn Trent Water** is responsible for providing effectual drainage on the public sewer network.

4.2 Actions taken by Authorities and the Community before the event

The City Council has an annual, cyclical maintenance regime of road gullies within the City Council area. As a minimum, each road gully is cleansed annually and requests for maintenance are responded to within three working days. The road gullies on Spondon Street are subject to this regime but not the car park which are cleansed by Nottingham City Council Parking Services on a reactive basis. The road gullies on Winchester Street and Haydn Road are included on the Targeted Gully Cleansing Regime which means they are cleaned more regularly and targeted prior to large rainfall events to ensure that they can function to their full capacity in storm events. This is a consequence of known historic flooding within the area.

It is likely that the road gullies and highway drains in the flooded area and the wider catchment were overwhelmed by the volume, flow velocity and depth of surface water flowing down roads and pathways. The highway drainage connects into the public sewer network and evidence suggests in a number of areas, surface water would have been unable to drain away via highway drainage because the public sewer network was close to or at maximum capacity.

Following flooding at Moores Place in June 2010, Nottingham City Council funded the installation of 0.6m high flood boards and smart airbricks to all affected properties to act as a temporary flood defence. At their maximum height the boards were approximately 350mm higher than the highway because of an approximate 250mm step down to the property entrance. This was followed by the construction of a permanent 0.6m high flood defence wall and flood gates along the front of the affected properties in June 2011 which was funded, without prejudice, by Nottingham City Council Ward Councillors as a gesture of goodwill (Figures 12 & 13). The severity of the storm and the

combination of flooding mechanisms on the 23rd July 2013 meant that this wall was overtopped and did not protect the properties in this event.

Figure 12: Flood boards installed following the storm in June 2010

Figure 13: Flood wall and flood gates constructed in June 2011.

Severn Trent Water has a programme of serviceability inspections on the public sewer network to inspect the condition of sewers and remove blockages. Modern water industry standards require the provision of sewerage systems that accommodate up to the 1 in 30 year storm event. The combined sewer on Haydn originates from an earlier period and may not reach modern day standards.

Severn Trent Water has carried out modelling of the public sewer network at Winchester Street prior to flooding in 2010 and carried out an update of the model in 2012 as part of the Haydn Road flooding investigation. Severn Trent Water recognises that there is hydraulic risk on the public sewer network at Winchester Street but this is currently considered low risk and the model does not have sufficient detail to justify capital investment at this time. The ordinary watercourse is not included within the network model at Winchester Street.

Interviews with affected residents have shown that some have experienced flooding before on Haydn Road and Winchester Street. On Winchester Street it is reported that some residents tried to temporarily block air bricks to stop the ingress of water into properties. These measures were also taken by some residents on Haydn Road, east of Hucknall Road, where sand bags were used to block up air bricks and doorways. On Haydn Road, west of Hucknall Road, those residents that were home during the storm closed the flood gates and installed flood barriers on the front doors. These measures were overwhelmed due to the flood volume during the storm. Due to the time of day and the flashy nature of the flood a number of residents were out of their properties on Winchester Street and Haydn Road during the storm and could not take any preventative measures.

4.3 Completed Action Plan

Surface water, highway drains and public sewers are closely linked. During this flood there is evidence of surface water being unable to drain into the highway drainage system and also evidence that sewers were flooding and contributing towards surface water volumes. Since the flood event of 23rd July 2013 Nottingham City Council and Severn Trent Water have worked in partnership to find solutions to reduce flooding in the area.

4.3.1 General

The flooding event of 23rd July 2013 on Winchester Street & Haydn Road occurred through a combination of sources. However, it is not well understood to what extent the interaction between surface water and public sewer flooding contributes to the flooding during a storm event. This is because anecdotal evidence in the form of eye witness accounts and video footage is often scarce. To better understand how the surface water, highway drainage and the public sewer interact Nottingham City Council has funded the placement of three CCTV cameras on Winchester Street and Haydn Road with the sole purpose of monitoring flood mechanisms during storm events.

Severn Trent Water has recorded the flooding on 23rd July 2013 for properties on Winchester Street & Haydn Road.

Nottingham City Council Actions	**Status**
Installation of CCTV camera's at strategic locations on Winchester Street and Haydn Road to monitor flood events in the area.	Completed 2015
Severn Trent Water Actions	**Status**
Maintain serviceability of public sewer system by inspecting and undertaking necessary remedial action (blockage removal etc).	Ongoing
Record the flooding on the 23rd July 2013 for properties on Haydn Road and Winchester Street.	Ongoing

4.3.2 Winchester Street

As the Lead Local Flood Authority under the Water Management Act 2010 Nottingham City Council have the powers to manage flood risk from ordinary watercourses. The City Council does not own the ordinary watercourse that flows from Woodthorpe Grange Park to Winchester Street however during the event of the 23rd July 2013 the ordinary watercourse overwhelmed the inlet to a culvert on Winchester Street and so contributed to flooding. Subsequent to the event the channel, bank and footpath behind the properties were cleared to remove any impediments to flow. Nottingham City Council does have the permissive powers to carry out works in the watercourse but does not have a statutory duty to maintain it as this duty rests with the riparian owner.

The watercourse enters a culvert beneath Winchester Street and joins with the main combined water sewer that flows to the south west along the road. This was identified by Nottingham City Council and Severn Trent Water as an area that required investigation. The City Council carried out a CCTV survey of the culvert to look for any blockages and as a result de-silted an inspection chamber to ensure that the asset operated at its optimum.

Nottingham City Council Actions	**Status**
Clearance of the ordinary watercourse that flows behind Cavendish Vale and joins the public sewer in Winchester Street to remove rubbish improve the conveyance of water.	Completed 2015
Carry out a CCTV survey of the culverted ordinary watercourse before it enters the public sewer on Winchester street to investigate any blockages.	Completed 2014
Remove silt from the inspection chamber for the culverted ordinary watercourse on Winchester Street to improve water conveyance into the public sewer.	Completed 2014
Severn Trent Water Actions	**Status**
Ensure flooding of the 23rd July 2014 is included on Severn Trent's records.	Ongoing

4.3.3 Spondon Street

Nottingham City Council identified that the car park drainage within the car park on the north side of Spondon Street was not acting efficiently and so contributing to the flooding during the event of the 23rd July 2013. Nottingham City Council Parking Services, as the owner, is responsible for the maintenance of gullies within the car park. Following the flooding on 23rd July 2013 the Drainage Team and Highways Services held discussions with Parking Services to clean and improve the car park drainage system. Parking Services will continue to provide maintenance of the gullies in the Spondon Street car park.

Nottingham City Council Actions	**Status**
Maintain Spondon Street car park gullies.	Ongoing

4.3.4 Haydn Road (west of Hucknall Road)

The storm on the 23rd July 2013 breached the flood wall on Moores Place. Whilst this wall would have protected against lower return period events, it was exceeded on this occasion.. To address this flood risk a partnership funded scheme between the Developer, Severn Trent Water & Nottingham City Council replaced the existing flood wall in August/September 2014 with a new 1.6m high reinforced flood defence wall and flood gates. This wall is higher than the level of Glamis Road to the north which means ponded water will have an overland flow route before overtopping the new flood wall. Properties have been further protected through the installation of flood resistant doors, new smart airbricks and non-return valves on all piping connected to the public sewer on Haydn Road.

As part of a wider road safety scheme and to improve highway drainage in the area Nottingham City Council funded the construction of underground storage east of Moores Place to hold water back water during storms allowing it to infiltrate away. Further to this a soakaway strip has been installed on Haydn Road between Warren Avenue and Ellesmere Cescent to remove some highway drainage and allow it infiltrate into the ground. Both these sustainable drainage measures are designed to reduce the amount of surface water runoff reaching the west end of Haydn Road.

To promote conveyance of surface water into the public sewer network the highway gullies on Haydn Road, near Moores Place have been supplemented by additional larger gully pots that have a larger capacity and have less risk of blockage. They also have new direct connections into the crown of Severn Trent Water's trunk sewer in the middle of Haydn Road. This will allow the maximum amount of surface water to enter the public sewer network.

Severn Trent Water's storage tanks on Haydn Road provide valuable relief for the public sewer network downstream of Hucknall Road. To improve understanding and monitor how the tanks are performing Severn Trent Water installed a new telemetry alarm system in November 2013 that provides a greater accuracy of how full they are at a given time. This will help determine how well the public sewer network is performing during storm conditions. Since the installation of this alarm system Severn Trent Water's records show there have been no instances of the tanks being beaten indicating that they are performing as designed.

Following the event of 23rd July 2013 Severn Trent Water has monitored and modelled the public sewer network on Haydn Road, to the west of Hucknall Road, and further downstream to identify any blockages or impediments to flow that could cause sewer surcharging. CCTV investigations proved to be unsuccessful but long term monitoring of the network suggests that there are not any blockages further downstream of Haydn Road.

Nottingham City Council Actions	**Status**
Construction of underground storage upstream from Moores Place to collect surface water and reduce the volume of water reaching Moores Place.	Completed 2015 as part of a road safety scheme on Haydn Road
Installation of large highway gullies on Haydn Road to improve the conveyance of surface water into the combined public sewer.	Completed 2015 as part of a road safety scheme on Haydn Road
Nottingham City Council, Severn Trent & the Developer Actions	
Replacement of the flood defence wall at Moores Place with a higher wall and flood gates and installation of flood resilient doors.	Completed 2014
Severn Trent Water Actions	**Status**
Installation of non-return valves to protect properties on Moores Place.	Completed 2014

Severn Trent Water Actions	Status
Monitoring and modelling of the public sewer network at Haydn Road and further downstream.	Completed 2013/14
Installation of a new telemetry alarm system on the overflow storage tanks at the Seven Trent Water depot on Haydn Road to provide real-time information about the capacity in the tanks during storm conditions.	Completed Nov 2013

4.4 Agreed future action plan

Any future solution to reduce the risk of flooding to the affected area would need to be undertaken in partnership between Severn Trent Water and Nottingham City Council.

The interaction between the highway drainage and public sewer network is complicated and must rely on both aspects functioning correctly to remove surface water effectively. Nottingham City Council will continue to maintain the road gullies on Winchester Street and Haydn Road under the Targeted Gully Cleansing Regime. This will ensure the maximum efficiency of the highway drainage during periods of high rainfall. The highway gullies on Spondon Street will remain part of the annual gully cleansing programme and the gullies in the car park on the north side of the road shall continue to be maintained by Nottingham City Council Parking Services.

Flooding within the urban environment is complicated and can be difficult to predict because of the interactions between rainfall, the urban landscape and drainage networks. Understanding the relationship between rainfall intensity and flooding can help predict future flooding and inform what preventative measures can be taken to mitigate flood risk. To provide better rainfall data for the Haydn Road/Winchester Street catchment Nottingham City Council will fund the construction of a rain gauge on top of the Severn Trent Water depot on Haydn Road. This will record rainfall data within the drainage catchment (Figure 1) and, combined with the CCTV cameras, provide a greater clarity of how the catchment reacts to storms of different sizes. All future flood risk schemes in the area will benefit from this data.

Nottingham City Council applied for funding from Central Government in March 2014 to support affected residents of flooding. This funding has been allocated for the financial years 2015/16 & 2016/17 to part fund appropriate property level protection like flood doors and smart airbricks within Nottingham City. The property level protection shall be made available to properties that fulfil the specific criteria of the funding and where funds are available.

Through the planning process Nottingham City Council will reduce the risk that any new developments in the area will cause additional flood risk to properties or businesses and where possible will incorporate features within the new development that could reduce flood risk.

Nationally, the modern public sewer network is designed to accommodate the 1 in 30 annual probability rainfall event. The rainfall event exceeded the modern design standard and Severn Trent Water therefore class the event as 'extreme'. Severn Trent Water prioritise investment in capacity improvements to the sewerage system based on risk, with the priority given to the most frequent and severe internal flooding. Currently, flooding in an extreme weather event beyond the design standards of the sewerage system does not meet criteria for a capacity improvement scheme at this time. Therefore this event does not trigger investment in a capital scheme in the area.

Severn Trent Water recognise that the drainage catchment has been subject to flooding on a more regular basis and are working in partnership with Nottingham City Council to ensure all flooding events are recorded. Both parties will work together to identify and consider any opportunities to improve flood risk in the area where funding allows. Severn Trent Water continues to monitor the performance

In addition other future actions are recommended which focus on improving community preparedness and resilience. The Action Plan below summarises the actions that have been agreed between Nottingham City Council and Severn Trent Water.

Nottingham City Council Actions	**Status**
Submit a funding bid to Central Government and / or the Regional Flood and Coastal Committee to support affected residents by part funding appropriate property level protection such as flood resistant doors and smart airbricks.	Bid submitted to Government in March 2014. Funding available in 2015/16 and 2016/17 subject to final approval.
Installation of a new rain gauge on top of the Severn Trent Water depot on Haydn Road to provide improved rainfall data for the catchment.	To be completed in the Summer 2015

Severn Trent Water Actions	Status
Ensure flooding of the 23rd July 2014 is included on Severn Trent's records.	To be completed in 2015
Monitor any future reported internal or external flooding incidents and the nature of the storm that causes flooding to identify any triggers for capital investment.	Ongoing
Monitor the performance of the offline storage tanks on Haydn Road.	Ongoing

4.5 Recommendations for affected residents

The table below contains recommendations for individual residents to improve resilience and preparedness.

Recommendations for Residents	Further Advice*
Residents should recognise that their property is vulnerable to future flooding in extreme rainfall events and make a **Flood Plan**, which involves ensuring that you have all of the information available that you may need in a flood event and helps you to consider what actions you will take if another flood occurs.	Environment Agency Personal Flood Plan Guidance: https://www.gov.uk/government/publications/personal-flood-plan
Residents should consider installing appropriate property level flood protection measures such as flood resistant doors and smart airbricks on their properties to prevent water entering the property and reduce the impact of future intense rainfall events.	Environment Agency 'What to do before, during & after a flood': https://www.gov.uk/government/publications/flooding-what-to-do-before-during-and-after-a-flood

Residents should maintain adequate flood insurance cover for the property. The National Flood Forum provides advice on flood insurance cover.	National Flood Forum website: nationalfloodforum.org.uk
Residents should report any blocked road gullies to Nottingham City Council so that the City Council can act quickly to resolve the issue.	See 'Contacts' on Page 36
Residents should report any future external or internal flooding to both Nottingham City Council and Severn Trent Water. If this information is reported it will support evident for future capital investment to reduce flood risk.	See 'Contacts' on Page 36

** Most documents referred to are available on the internet. These can be provided by Nottingham City Council in hard copy format upon request. See 'Contacts' section on page 19*

5 CONCLUSIONS

19 residential properties and 1 commercial property were flooded internally on Winchester Street, Spondon Street and Haydn Road during the storm event on 23rd July 2013. A series of three heavy rainfall events passed over the City on 22nd and 23rd July that saturated the ground and filled available storage in underground drainage networks. A fourth rainfall event passed over Nottingham at 17:00 on 23rd July resulting in the internal and external flooding of domestic and commercial properties in the area. The properties that were affected are in low lying areas of a natural valley that forms the Sherwood area.

Nottingham City Council and Severn Trent Water are the Risk Management Authorities that have flood risk management functions in relation to the flood event. Nottingham City Council is responsible for managing the risk of flooding from surface water and highway drainage and Severn Trent Water is responsible for providing effectual drainage and public sewers (surface water sewers and foul sewers). Due to the complex nature of the interactions between surface water and public sewers the City Council and Severn Trent Water have worked in partnership to investigate the flooding and agree an action plan.

Historical flooding recorded on Winchester Street and Haydn Road meant that the highway drainage in the area had been included on the Targeted Gully Programme prior to the event. Severn Trent Water had previously installed two offline storage tanks on Haydn Road, near Hucknall Road, to alleviate pressure on the public sewer network downstream of Haydn Road.

The four areas affected by the flooding on the 23rd July 2013 are hydraulically linked within a drainage catchment that is approximately 2 km^2. The predominant flow is west towards the River Leen from the surrounding high ground in Mapperley to the east, Perry Road to the north and Arlington Road/Herbert Drive to the south.

Flooding occurred within the catchment due to the excessive surface water caused by the storm overwhelming both the highway drainage and public sewer network. This was further exacerbated on Winchester Street through the overtopping of the ordinary watercourse that flows from Woodthorpe Grange Park and enters the public sewer through a culvert on Winchester Street. The steep slope of the land surrounding the catchment meant that surface water was conveyed rapidly from east to west allowing little time to put in place preventative measures. Evidence from Winchester Street and Haydn Road suggests that the capacity of the public sewer network was exceeded during the peak of the storm and was acting in reverse.

Due to the extreme nature of the rainfall event the flooding incident does not meet Severn Trent's criteria for capacity improvement at this time and therefore the actions that the City Council and Severn Trent Water have agreed focus on the continued maintenance of the existing drainage systems so that they operate at maximum efficiency during rainfall events. However, Severn Trent

Water, Nottingham City Council & the Developer have worked in partnership to build a new flood defence wall at Moores Place and install property level protection to the affected properties. Severn Trent Water are aware of flooding incidents in the area and will continue to monitor future storm events and opportunities to improve flood risk through partnership and business schemes.

Nottingham City Council has recognised the need to monitor rainstorm events within the drainage catchment and has installed three CCTV cameras on Winchester Street & Haydn Road to identify the interaction between the highway drainage, the ordinary watercourse & the public sewer network. This will be augmented by the installation of a new rain gauge within the catchment to improve rainfall analysis of storms which can be used as an evidence base for future schemes. Highway drainage on Haydn Road has been improved through the creation of large gullies, underground storage and a soakaway to store and infiltrate water back into the ground during storm events.

A number of recommendations have been made for residents to improve the level of preparedness and resilience of their properties. It is also important for residents to report any future flooding issues to Nottingham City Council and Severn Trent Water.

6 DISCLAIMER

This report has been prepared as part of Nottingham City Council's responsibilities under the Flood and Water Management Act 2010. It is intended to provide context and information to support the delivery of the local flood risk management strategy and should not be used for any other purpose.

The findings of the report are based on a subjective assessment of the information available by those undertaking the investigation and therefore may not include all relevant information. As such it should not be considered as a definitive assessment of all factors that may have triggered or contributed to the flood event. Nottingham City Council expressly disclaim responsibility for any error in, or omission from, this report and the supporting technical assessment Report arising from or in connection with any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the time of preparation and Nottingham City Council expressly disclaim responsibility for any error in, or omission from, this report arising from or in connection with those opinions, conclusions and any recommendations.

The implications for producing Flood Investigation Reports and any consequences of blight have been considered. The process of gaining insurance for a property and/or purchasing/selling a property and any flooding issues identified are considered a separate and legally binding process placed upon property owners and this is independent of and does not relate to the City Council highlighting flooding to properties at a street level.

Nottingham City Council does not accept any liability for the use of this report or its contents by any third party.

7 CONTACTS & USEFUL LINKS

Nottingham City Council Contacts & Links		
Drainage Team	0115 8765275 or 01158765279 *Monday to Friday 9:00-17:00*	*For advice on improving the level of protection to your property*
Highway Services Team	0115 9152000 *Monday to Friday 9:00-17:00* Online reporting: www.nottinghamcity.gov.uk/article/26940/Report-a-fault	*To report problems with blocked road gullies or flooding incidents during office hours*
Emergency Contact	0115 9152222 *Out of office hours*	*To report emergency flooding incidents out of office hours*
Useful Web Pages	http://www.nottinghamcity.gov.uk/article/25423/Flooding	
Severn Trent Water Contacts		
Emergency contact	0800 783 4444 *24 hours*	*To report flooding incidents or blockages on sewers*
Environment Agency		
Floodline	0345 988 1188 *24 hours*	*For advice on current flood warnings*
Useful web pages	https://www.gov.uk/government/publications/flooding-what-to-do-before-during-and-after-a-flood	
Emergency Services		
Non Emergency Contact	101	

8 APPENDIX A: MAPS AND POLICY

Table A1: Nottingham City Council Thresholds for Initiating Flood Investigations on residential properties. (Section 19 Flood Investigation Policy)

Threshold / Trigger	Included	Excluded
• All incidents where internal flooding affects five or more properties and the properties are either in close proximity or the flooding is hydraulically linked. • Where there is uncertainty around the cause of flooding or the responsible Risk Management Authority, regardless of the number of properties affected. • Where the frequency or impacts of flooding are particularly severe, regardless of the number of properties affected.	'Internal' flooding relates to: • Flooding of any area of a property that was originally intended to be habitable at ground floor level and above e.g. kitchen, reception rooms, sleeping accommodation. • Flooding of a sub-surface structure, such as a basement or cellar, where the floodwater contains sewage or other contaminants that cause concern for public health.	The following exclusions relate to the definition of 'internal' flooding: • External areas such as gardens, driveways and paths. • Structures that were not originally designed to be part of the habitable property such as sheds, summer houses, conservatories or garages. • Flooding of a sub-surface structure, such as a basement or cellar, where the floodwater does not cause concern for public health.

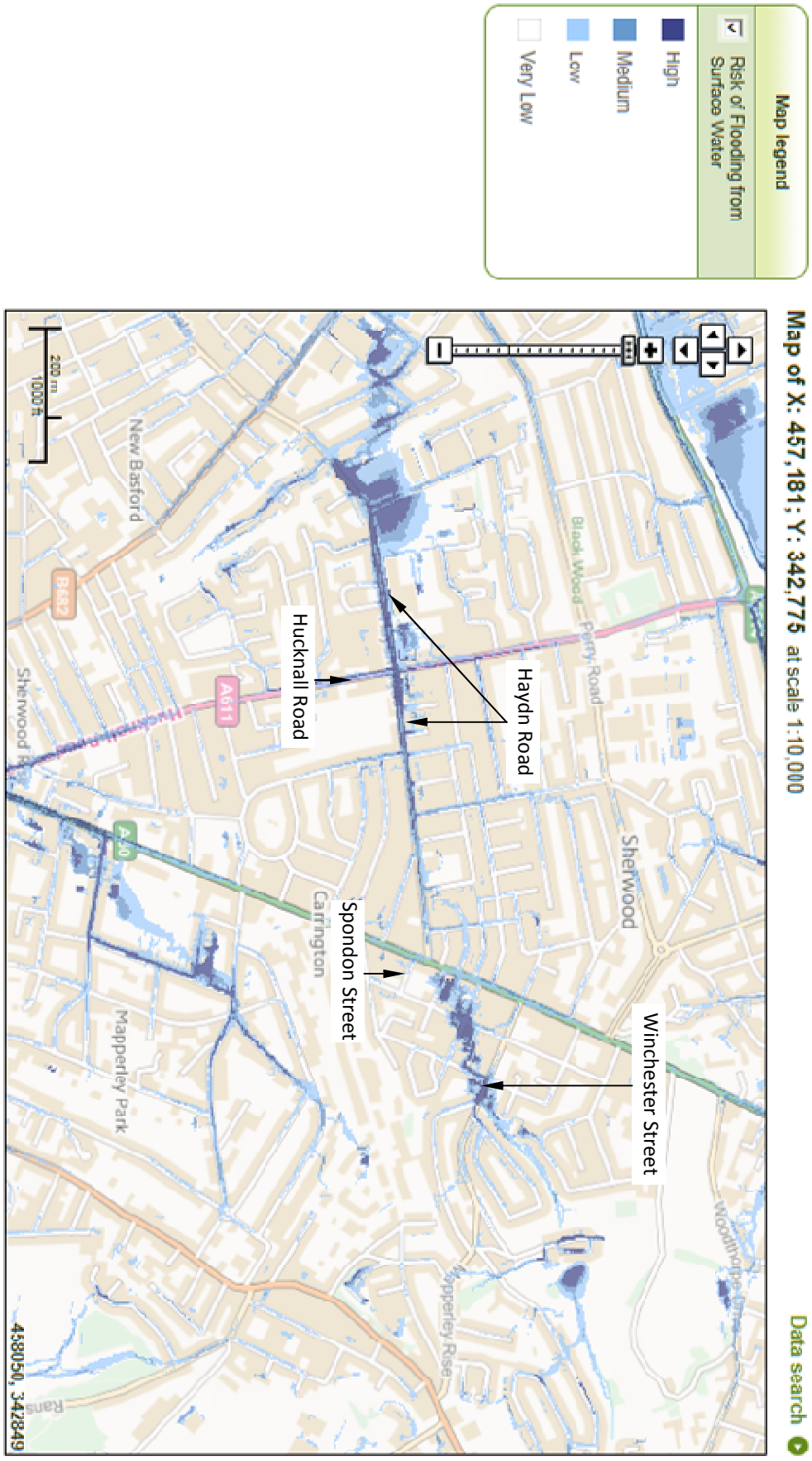

Figure A-1: Environment Agency Flood Map for Surface Water